# THE SYSTEM OF TEMPERATURE AND WATER PH MONITORING AND CONTROL ON AROWANA FISH FARM BREEDING (SCLEROPAGES FORMOSUS) USING IOT BASED FARM AQUACULTURE

**By**
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**Abstract**

*This research was conducted in December 2022 arowana fish property PT. Aquafam Jaya Lestari in cultivation, Riau Province. It was aimed to designinternet of things technology that expected to help arowana fish farmer in monitoring and controlling more effectively and practically. The method used for this research is case study and respondents were taken is the arowana farmer.In monitoring arowana fish water quality, most farmers still adopt traditional farming models that rely too much on experience, which cannot make scientific judgments on water quality and environmental changes. UsingArduino, LoRa, cellular technology and integrate with a variety of sensors and automatic devices (for example: temperature sensor, pH sensor, water pump, selenoid, aerator), it provides a smart solution for water quality monitoring to create tightly controlled and sustainable growth conditions. The system changes all the time to collect the data of temperature and pHand automatically adjust the temperature and pH to best treatment that pH range 6.5 – 7.5 and temperature 26 – 30°C . The final result of this research is analisys data by comparing 3 treatments on arowana with different pH and temperature.Observation result shows that the treament with pH range 6.5 – 7.5 and temperature 26 – 30°Cthe fish will provide an optimum response to the feed so that growht well and faster and will be able to produce optimally.*

***Keywords: Internet of thing, LoRa, Smart Solution, Arduino***

## INTRODUCTION

The golden-red Mahato arowana fish is a prehistoric species that is on the verge of extinction if not preserved. In its 2012 annual report, the World Living Natural Resources Conservation (IUCN) [1]lists the Golden-red Mahato arowana fish as one of the endangered fauna.

One method for preserving the arowana fish population is to conduct captive breeding under government supervision by issuing special permits.However, arowana captive breeding in Indonesia is experiencing issues with its water temperature and pH monitoring system, even though water temperature and pH are critical parameters to monitor in captivity activities. Water temperature and pH have a significant impact on arowana fish survival. The pond environment's temperature will affect the fish's digestive and immunological systems. The optimal temperature in the breeding pond ranges from 26 - 30 °C, with no substantial fluctuation in temperature between day and night. When provided food, the fish will respond optimally, and its immune system will likewise function well. Temperatures above 30°C make fish slow to move and allow parasites such as fungus and bacteria to proliferate and infect fish quickly, but temperatures below 26°C lead fish to lose their

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appetite and damage their immune system. While the recommended pH range is between 6.5 and 7.5, fish will grow optimally in that range.

Yu-Cheng Lin (2017) [2]conducted a previous study in which researchers utilized Arduino as a microcontroller and connected it to a temperature sensor and turbidity sensor for control using a pump and relay as ON/OFF and carried out the experiment in a closed container such as an aquarium. Previous studies have identified several flaws, such as researchers failing to consider that water temperature is greatly influenced by the sun, temperature, weather, and climate, and that only using aquarium media in a closed room will not significantly affect the existing water temperature; additionally, researchers must consider including The pH sensor is an important sensor in monitoring water quality. The amount of hydrogen in the pool water truly affects the pH of the water, where the degree of acidity can be evaluated using a pH-Meter, that is, if the pH is too low, it will be acidic, otherwise if it is too high, it will be alkaline. Both of these factors disrupt the development and growth of fish in the pond. The pH of fish pond water is generally between 6.5 and 7.5. There are numerous reasons why the pH value is lower or higher than normal. For example, fish feed, microorganisms in the pond environment, sunlight absorption, or ancient pond water.Other research conducted byFariza Halidatsani AzhraChaerul Anam[3]creating a system that can assist fish farmers in managing water quality in ponds. This research uses arduino microcontroller and arduino software. The test results show that the accuracy of the sensor with a value of 80%, that’s mean that the sensor is accurate and can be used in the system.

To overcome these deficiencies, this research develops and designs a more practical and effective water quality monitoring and control system through case studies conducted directly in fish ponds. The fish pond used is PT. Aquafam Jaya Lestari. The update of this research is a system for monitoring and controlling the temperature and pH of water in arowana fish ponds by utilizing IoT technology. From that, this system is expected to help fish farmers, especially arowana fish, in monitoring the temperature and pH of the water so that the water quality in fish ponds can be well controlled. In making the system there is an Arduino Uno microcontroller used in this study to monitor and regulate the temperature and pH of the water. The NoteMCU ESP32 board will be connected to the DS18B20 temperature sensor and the PH4502C pH sensor, and data from the sensors will be transferred directly to the Blynk platform in real-time. The built system can measure pH on a scale of 0 to 14 and temperature on a scale of -10°C to 100°C, sensor measurement results can be displayed in data or graphic form on a monitor or smartphone, and SMS notifications can be sent using a gateway system, for control. yourself, making it easy to do it automatically or manually by pressing the Blynk platform that has been set up.

## RESEARCH METHODS

### Area Study

This research activities were carried out directly in the arowana fish breeding pond of PT. Aquafam Jaya Lestari, Karya Indah Village, Tapung District, Kampar Regency, Riau Province.This pond has been operating for about 2 years in an area of around 10.000 square metersand consists of 16 ponds with 12x23M for each pond and total number of broodstock of around 200 fishes. This location was chosen purposefully because it is one of the arowana fish breeding locations that has a permit from the Ministry of Marine Affairs and Fisheries.

**Figure1.Research Area**

**Block diagram**

Figure 2 show the block diagram of system. The Sensor will interface with the microcontroller NodeMCU ESP32 that acts as an open-source IoT platform. It will send the data to cloud storage which is the Blynk server that has been developed to store the data and information. Arduino IDE is a programming language that support library for Blynk that connect to hardware over Wi-Fi. Blynk application is a platform with IOS and Android apps to control NodeMCU ESP32 through its inbuilt Wi-Fi shield. It can display the digitalized information data from the sensor

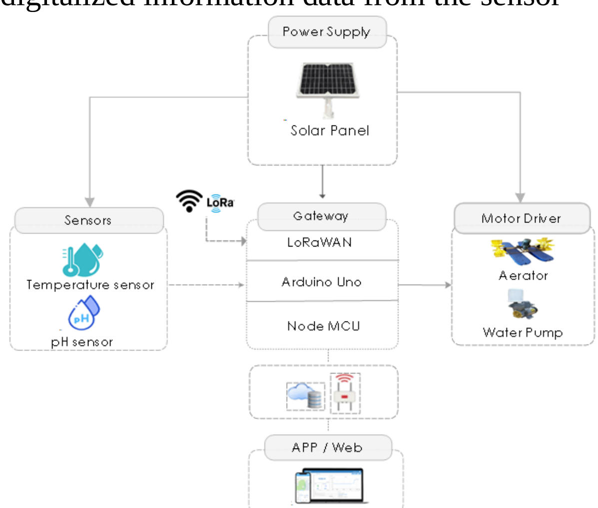


**Figure 2.Block diagram**

**Connection Diagram**

Figure 3 shows the connection diagram of the system.

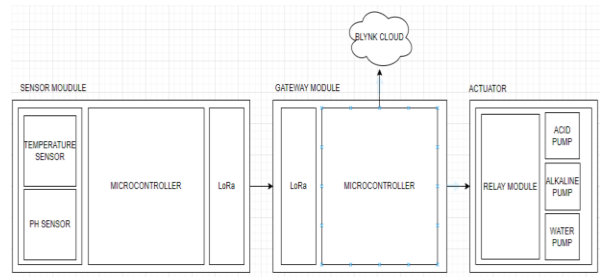


**Figure 3**. Connection Diagrams

**Flowchart**

Figure 4 and 5 shows the flowchart of the system. The flowchart starts by having two sensors (temperature and pH)

The procedure started with the connection of a temperature sensor (DS18B20) and a pH sensor (PH4502C) to NodeMCU (ESP32). The data was then saved to a cloud database.

NodeMCU will read the database to examine the Temperature and pH sensor values, and the results will apply the following conditions:

If the pH is more than >7.5 (alkaline), the water drums-2 pump (pH-lowering liquid) will activate and drain the liquid prepared to decrease the pH of the water from water drums-2.

The liquid in water drum-2 that we used here was ketapang leaves which have been deposited for 24 hours. Besides being effective, economical, and natural, the selection of ketapang leaves also contains tannins and flavonoids which are antibacterial. Antibacterial compounds such as ampicillin, higomicin, kanamicin, and rifampicin can inhibit the growth of several bacterial colonies that act as a biocontrol agent. The administration of ketapang extract showed inhibition on several bacteria such as *Aeromonas salmonicida*, *eromonas hydrophila*, *Escherichia coli*, and *Staphylococcus aureus*was stated byPutricia V (2016)[4]. If the pH of the water is < 6.5 (acidic), water drums-1 (which raises the pH of the water) will activate and drain the liquid from water drums-1, which has been prepared to raise the pH of the water. The liquid used in water drum-1 is limestone that has been deposited for 24 hours, limestone can increasing the pH of the water, another important function of liming is to increase the effectiveness of the pond fertilization process so that so that it is not difficult to break down organic matter. Difficulty decomposing organic matter can cause the pond's fertility level to be low so that the natural feed content in the pond is also reduced, limestone can be employed in the long run stated by Karlina, Lina (2010)[5]

In this circumstance, the aerator will also be activated, with the goal of the aerator producing air bubbles and oxygen in the air to diffuse into the pool water and improve the pH of the water. If the temperature is < 26°C or > 30°C then the water pump will be ON to replace some of the pool water up to what temperature is in the range of 26 - 30°C.

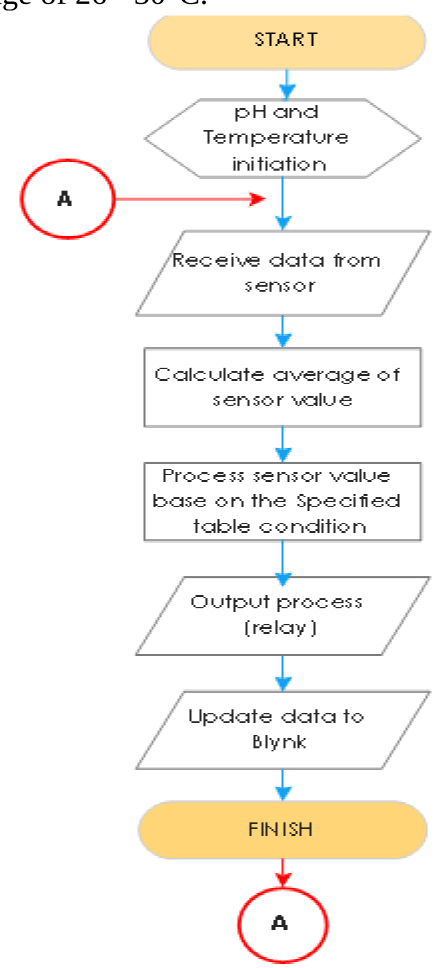


**Figure 4.** FlowchartGateway Module

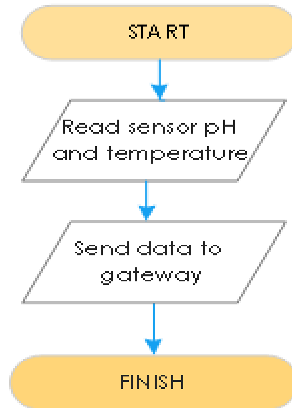


**Figure 5.** Flowchart sensor module

**Hardware Development**

a. NodeMCU ESP32 which is a development board featuring the popular ESP32 Wi-Fi chip. As it turns out, it can program the ESP32 just like any other microcontroller. Its obvious advantage over the Arduino or PIC is that it can readily connect to the Internet via Wi-Fi. The NodeMCU solves this problem by featuring 10 GPIO pins each capable of using PWM, I2C and 1-wire interfaceproblem by featuring 10 GPIO pins each capable of using PWM, I2C and 1-wire interface.

b. Analog pH sensor that is to measure water whether is acidic or alkalinity. The pH scale is a logarithmic scale whose range is from 0 – 14 with a neutral point being 7. The value above 7 indicates an alkaline solution and values below 7 would indicate an acidic solution. It operates on a 5V power supply and it is easy to interface with NodeMCU. The optimal pH range for fishes is 6.5 to 7.5. Low and high pH level harms fish especially the young fish in immature stages because they are extremely sensitive to pH levels.

c. Temperature sensor (DS18B20) is a waterproof sensor which detects the temperature of its surrounding. Most of the functions in this development are sensing variables in water, thus the DS18B20 being waterproof helps in detecting the temperature of water without being damaged. It can measure extreme temperature from -55 °C to 125 °C with very good accuracy. The normal range temperature for fishes is 26 °C to 30 °C.

**Software Development**

a. Arduino IDE Figure 6is software which is an open-source software used to implement hardware and software. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards. This software allows interference between NodeMCU and the sensors.


**Figure 6.** Arduino IDE Software

b. Blynk application Figure 7 is used to connect data in the microcontroller to the smartphone. For this project, the Blynk application connected with NodeMCU to the cloud using a Wi-Fi connection. It displays the data and the graph on the smartphone

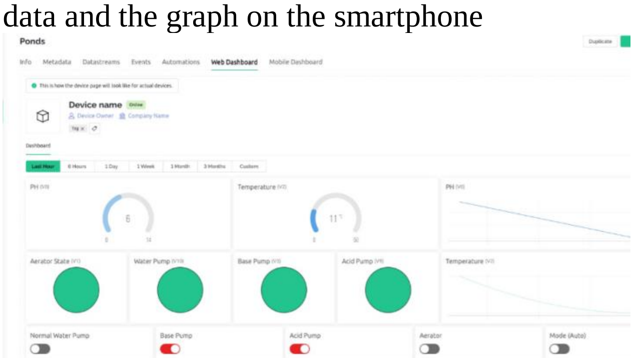


**Figure 7.** Blynk Application

c. Fritzing. Figure 8 is Fritzing software. Fritzing is used to design the circuit beforehand and is used for simulation before transferring it onto hardware.

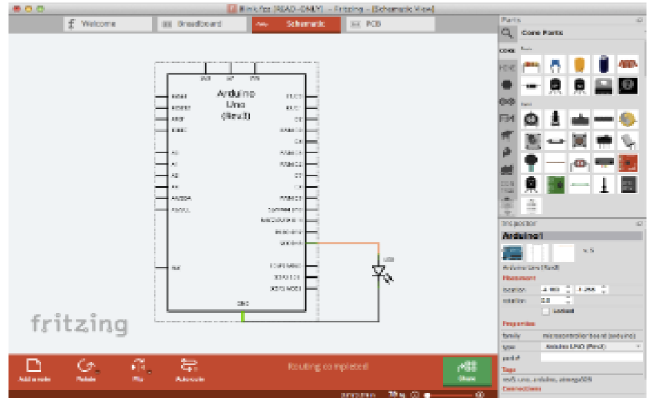


**Figure 8.** Fritzing Software

## FINDING AND DISCUSSION

A. Hardware realization

Display of hardware circuit components shown as Figure 9

**Figure 9.** Display of hardware circuit component

**Figure 10.** Display of gateway module

**Figure 11.** Display of Sensor

**Figure 12.** Display of whole componennt

B. Testing the reading of the pH sensor

The pH sensor's output is in analog form, which is subsequently translated to a digital voltage of 3.3V. The output voltage is then transformed back into a pH value. This sensor was tested by comparing the results of direct measurements in the breeding pond between the pH 4502C sensor and a pH-Meter. This test was carried out by gathering data from up to ten samples. The sample collected is the pH sensor 4502C value and the pH-Meter value used to calculate the comparison of the pH sensor 4502C value with the pH-Meter of the water. The data in Table 1 show that the pH sensor (PH4502C)has an accurate result of 98.70%.

**Table 1**Test results of pHsensor (4502C) and pH-Meter

| pH measurement with pH-meter | pH measurement with PH4502C sensor | Error% |
|---|---|---|
| 6.60 | 6.70 | 1.52 |
| 6.63 | 6.74 | 1.66 |
| 6.70 | 6.82 | 1.79 |
| 5.00 | 5.12 | 2.40 |
| 6.80 | 6.87 | 1.03 |
| 6.82 | 6.85 | 0.44 |
| 6.84 | 6.94 | 1.46 |
| 7.80 | 7.95 | 1.92 |
| 7.43 | 7.48 | 0.67 |
| 7.41 | 7.42 | 0.13 |
| Average Error | | 1.30 |

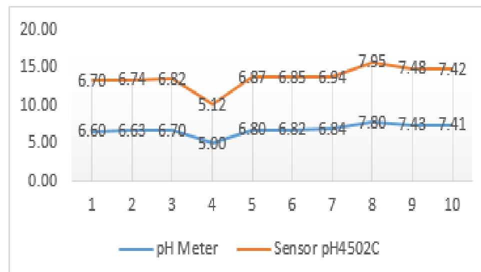


**Figure 13.**Graph of test results ofpH sensor (pH4502C) and pH-Meter

To ensure the accuracy of the pH probe, the pH-Meter must be calibrated periodically, generally, this period is about half a year. This sensor module is packaged in a waterproof form so that it can be immersed in water. The analog voltage output range is 0-3Vdc, and the power input is 3.3- 5.5Vdc.

**Figure 14.** Test result of pH-Meter with digital multimeter

As shown Figure 11, the result of the pH-meter test with digital multimeter show output of the voltage is 3.5V

C. Testing the reading of the temperature sensor

The temperature sensor output results are digital, allowing them to be viewed directly without being transformed. This sensor was tested by obtaining samples for 10 days and comparing the results between the DS18B20 sensor and a water thermometer. The sample is the difference in temperature between the DS18B20 sensor and a water thermometer. The comparison of the results provided by the DS18B20 sensor with a water thermometer is determined through sampling data collecting. According to the statistics in Table 2, the temperature sensor (DS18B20) has an accuracy rate of 98.10%.

**Table 2.** Test results oftemperaturesensor (DS18B20) and digital infrared thermometer

| Temperature measurement with a digital infrared thermometer (°C) | Temperature sensor DS18B20 measurement (°C) | Error% |
|---|---|---|
| 27.90 | 28.20 | 1.08 |
| 27.40 | 27.70 | 1.09 |
| 28.00 | 28.50 | 1.79 |
| 24.00 | 24.20 | 0.83 |
| 29.00 | 30.90 | 6.55 |
| 27.90 | 28.20 | 1.08 |
| 26.90 | 27.30 | 1.49 |
| 32.00 | 33.20 | 3.75 |
| 28.60 | 28.90 | 1.05 |
| 28.50 | 28.80 | 1.05 |
| Average Error | | 1.98 |

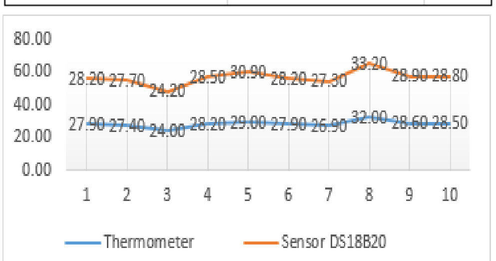


**Figure 15.**Graph of Test results of DS18B20 temperature sensor and Digital Infrared Thermometer

D. Overall Test Findings

The results of this test are the results of monitoring data sent by NodeMCU and then displayed on a Computer orAndroid screen as shown in Figure 13.

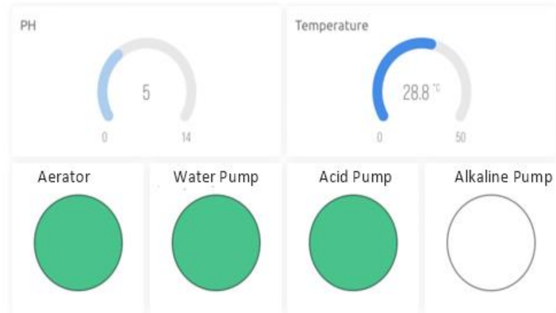


**Figure 16.** Display of pH lower, temperature Normal

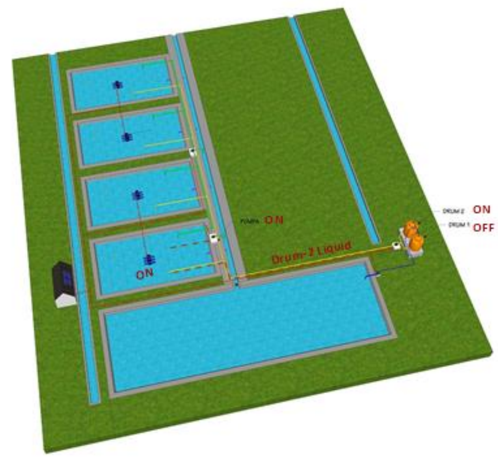


**Figure 17.** Aerator ON, Pump ON, Drum-2 ON, Drum-1 OFF

All testing condition shown as table 3 base on the pH and temperature sensor value.

**Table 3.** Actuator Status

| pH | Temperature | Actuator status |
|---|---|---|
| < 6.5 | < 25C° atau > 30C° | Aerator ON, Pump Drum-1 ON, Water-Pump ON |
| < 6.5 | 26 - 30C° | Aerator ON, Pump Drum-1 ON |
| 6.5 - 7.5 | 26 - 30C° | ALL Actuator OFF |
| > 7.5 | < 25C° atau > 30C° | Pump Drum-2 ON, Water-Pump ON |
| > 7.5 | 26 - 30C° | Pump Drum-2 ON |

The data is displayed using the Blynk Platform that has been prepared.The Blynk platform is used to monitor Temperature and pH in real-time during tests. The Temperature and pH values were compared for 10 days to three treatments, namely A (pH below 6.5 and temperature below 26°C), B (pH between 6.5 - 7.5 and temperature between 26 - 30°C), and C (pH above 7.5 and temperature above 30°C). From the data taken in Table 4 which was carried out for 10 days (Monday – Sunday – Wednesday), it can be seen that the best treatment for arowana fish is treatment A pH 6.5 – 7.5 and temperature 26 – 30°C. This is because, in this treatment, arowana fish swim nimbly and feed as much as 1 kg of feed after each feeding with a duration of 2 times a day in the morning and evening resulting in the optimum weight of the arowana fish being maintained. Treatment B has a pH of 5 - 6 and a temperature of20 - 25°C, which is why on day 4 (Thursday), the treatment causes the arowana fish to flutter above the surface of the pond due to a lack of oxygen, which can cause a decrease in the fish's breathing rate and heart rate so that if conditions worsen, the fish will faint. In this condition, the fish do not respond well to feeding; half of the 1 kg of feed given is consumed. As a result, the fish's growth is suboptimal. The C treatment with pH 7.5 - 10 and temperature 31 - 35 is not ideal since on day 8 (Monday), high temperatures might lower oxygen levels, causing fish to lose appetite and, in the long run, affecting fish development and reproduction. Only half of the 1kg food is spent, resulting in a less optimal fish response to feeding.

**Table 4**. Response of fish to feeding

| Treatment | pH | Temperature | Feed AMount (KG) | Fish respor feedin |
|---|---|---|---|---|
| A | < 6.5 | < 26C° | 0.5KG | Less Optir |
| B | 6.5 - 7.5 | 26 - 30C° | 1.0KG | Optimum F |
| C | > 7.5 | > 30C° | 0.5KG | Less Optir |

## *1. CONCLUSION*

Based on the results of testing and analysis of the Internet of Things (IoT)-based monitoring system for Temperature and pH in arowana fish farming, the following conclusions can be drawn: 1). The IoT-based monitoring system for temperature and pH in arowana fish farming has been completed and can be effectively managed to provide the most suitable environment for fish living. 2). Since fish can be monitored in real-time, the failure rate of cultivator output may be decreased; 3). Blynk platform can be used to monitor data on built-in control systems; 4). The results of a comparison test between the temperature sensor and a water thermometer and the pH sensor and a water pH-Meter revealed no significant difference and a high degree of accuracy; 5). LoRa can cover upto 2KM wide coverage in a fish pond environment.

For future development, it will be developed for testing in all ponds with the addition of several sensors such as sensors for measuring oxygen levels and water turbidity

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